NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

LAND RECLAMATION

SUBSIDENCE TREATMENT

(ha, acre)
CODE 454

DEFINITION

Treating subsidence areas to reduce the harmful effects and provide for beneficial use.

SCOPE

This standard applies to surface subsidence associated with abandoned underground mines in rural areas that are being treated as part of surface reclamation. Open sinkholes caused by mine collapse are covered by the shaft and adit closing standard (452).

PURPOSE

Subsidence is treated to minimize damages where high-valued improvements are involved or where there is high hazard to human life. It is also treated to reduce pollution of surface and ground water, prevent soil degradation, improve landscape resource quality, and restore or maintain a beneficial use.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to locations where surface subsidence from the collapse of underground mining is threatening rural buildings and structures, roads, dams, and ponds; decreasing land values; interfering with surface drainage or water supplies; creating a hazard to human life; damaging landscape values; and creating a nuisance or preventing beneficial use.

PLANNING CONSIDERATIONS

1. Geologic environment of the immediate area, including characteristics of overburden such as lithology, faults, joints, and attitude.
2. Surface and subsurface hydrologic conditions.
3. Mining history.
4. Postmining history and conditions.
5. Land use.
6. Vertical and horizontal dimension of voids.
7. Depth of voids below land surface.
8. Size, type, and distribution of pillars.
9. Surface topography and drainage pattern.
10. Availability and quality of backfill material.
11. Availability of slurry water.

General

If high-valued improvements or danger to human life are involved, the hazard can be reduced by backfilling the mined-out areas under and adjacent to the improvements with hydraulic or blind backfilling. If the mined-out voids are not too deep, a stripping operation can be used to eliminate present and further subsidence problems. Surface treatment may be used to reduce the harmful effects, recognizing that future subsidence may occur and additional treatment will be necessary.

NRCS, TX
May, 2000

DESIGN CRITERIA

Controlled backfilling. Controlled backfilling methods can be used where the mine is accessible and can be traversed to key areas for the filling operation. Bulkheads are built in mine passage around the periphery of the work area for containment of the fill. Drains may be incorporated in the bulkheads to facilitate rapid water removal. Bulkheads are built of wood or other suitable material. Vertical injection boreholes should be minimum of 30 cm (12 in) in diameter. At the base of each hole, a 90° long radius pipe elbow is placed whereby the slurry can be diverted to horizontal pipes and distributed into the mine workings. Boreholes through bulkheads may also be utilized.

Blind backfilling-gravity method. If abandoned mine openings are inaccessible because of flooding or caving, blind backfilling must be used. Pipes are installed from the surface into the mine openings through drill holes and granular material is flushed in with water under the force of gravity. In the gravity feed method, the injected granular material builds a cone under the injection pipe. When the cone builds up to the mine roof, no more fill will enter the mine and a new hole must be drilled.

Blind flushing pumped-slurry injection. In the pumped-slurry method, durable granular material is blended with water, and the suspension (slurry) is pumped to the point of injection. Energy provided by the pump and the static head in the borehole give the velocity required to keep the solid particles in suspension and to transport them. As the slurry firsts enters the open space, its velocity drops rapidly, and the sold particles settle out in a mound. As the mound approaches the mine roof, the velocity of the slurry increases through the narrowing channels, and the solid particles are transported to the outer limits of the mound. Here the velocity again decreases abruptly, the solids are deposited, and the mound is built outwards until resistance to flow reduces the velocity below that required to transport the solids. This may be several hundred feet, depending on particle size and concentration and other factors. Exploratory drill hoes may be needed to determine the extent and effectiveness of backfilling.

Daylighting. Stripping, replacement of the overburden and complete reclamation are the most effective methods of subsidence treatments. The hazard to personnel and equipment caused by the subsurface voids is a major consideration in planning equipment movement and mining operations; therefore, the plan must include procedures to establish firm support. It may be necessary to excavate and backfill the anticipated travel paths ahead of the complete stripping operation. If the remaining coal is not to be removed, care must be taken to open all rooms and travelways and ascertain that they are completely backfilled with overburden material before initiating other backfill operations.

Surface treatment. Surface filling of subsidence areas is usually applicable when drainage cannot be obtained or other important factors make filling a practical alternative. Some areas of subsidence may be considered low hazard and sufficiently stable to permit land use operations after surface filling. Drainage systems can be used to eliminate excess water. Diversions can be used to keep runoff water from entering the treatment areas, and land smoothing and grading can be used to ensure positive drainage. Pumped drainage may be necessary if a gravity outlet is not available.

Borrow areas. Any areas used for borrow for backfill operations should be reestablished to their proper uses in accordance with appropriate SCS standards.

Environmental. All disturbed areas shall be reshaped and regraded to blend with surrounding land features. Visual resources must be given the same consideration as other design features in planning, design, and installation. Exposed areas of earth shall be covered with soil materials and established with vegetation or protected by other means as soon as practicable. Access roads must be maintained and foot and vehicular traffic controlled to protect the work.

MAINTENANCE

Sites must be monitored to determine the effectiveness of the backfilling. Surface

treatment may be required to reduce the harmful effects of subsidence.

PLANS AND SPECIFICATIONS

Plans and specifications for subsidence treatment shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

LAND RECLAMATION, SUBSIDENCE TREATMENT SPECIFICATIONS

FOUNDATION PREPARATION

Access shall be carefully controlled to preclude accidents to machinery, equipment, and personnel. Mechanical impact devices shall be used to locate safe routes for machinery and hauling equipment if shown on the plans or if required in the contract documents.

The foundation shall be cleared of trees, brush, and other debris as necessary for construction operations. Wastes shall be disposed of at designated locations. All subsidence holes or other subsided areas shall be shaped to sizes and grades as specified.

EXCAVATION (DAYLIGHTING)

This operation consists of removing the overburden to the mine tunnels and shafts and filling the mine voids with overburden excavation. The approximate extent of the mine voids area is shown in the plants. The actual extent will be determined during the excavation. All abandoned mining equipment found in the mine shall be disposed of as specified. The backfill shall be placed in lifts and compacted as specified. The surface area shall be left in a smooth condition suitable for placement of topsoil.

FILLING UNDERGROUND VOIDS

Fill material shall be mine tailings, soil, fly ash, or other approved material. Materials shall be placed by pneumatic stowing. The system must be capable of placing materials 75 mm (3 in.) or smaller. The materials shall be placed to 80 percent of standard Proctor density. Water shall be added to control dust. If a soil cement seal is required, enough water shall be added to provide for proper soil cement sealing.

SURFACE TREATMENT

Diversions, precision land forming, surface drains, and subsurface drains shall be installed according to the requirements shown in the plans.

PROTECTION

Bare soil areas not to be farmed are to be protected by vegetation. Other materials may be used if soil and climatic conditions preclude the use of vegetation.

Appropriate safety measures shall be taken during and after construction. Such measures include warning signs, rescue facilities, gas-warning meters, fences, and mechanical impact testing.

Planning considerations for water quantity and quality

Quantity

1. Effects on the water budget, especially on volumes and rates of runoff and ground water recharge.

Quality

1. Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff to surface and ground water.

2. Effects on the movement of dissolved substances to ground water.

3. Potential for uncovering or redistributing toxic materials that might cause undesirable effects on water or plants.

4. Short-term, construction, and maintenance effects on the quality of water resources.

5. Effects on wetlands or water-related wildlife habitats.

6. Effects on the visual quality of water resources.